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THE CHEMISTRY OF VITAMINS[1]

THE existence of substances to which the name vitamin has been given was first recognized some fourteen years ago, and since that time much information has been obtained concerning their source, distribution, physiological and other properties, but comparatively little in regard to their chemical structure. This has been due to the fact that until recently it has not been possible to isolate any one of them in a relatively pure condition.

The difficulties in connection with the purification of vitamins have been due, among other things, to the complex character of the raw materials in which they occur, the small percentage present, the destructive effect of many of the reagents and laboratory manipulations used for their fractionation and finally, the want of a reliable chemical test by which the success of the purification steps could be controlled. In the absence of a chemical test it has been necessary to rely upon feeding experiments, which require much time and do not give uniformly dependable results.

In spite of the difficulties which have and will be encountered in the chemical study of vitamins, it is one of the most attractive problems which can occupy the attention of an investigator. The several vitamins perform essential functions in the nutrition of animals and on them depend growth, health, reproduction and completion of the life cycle. There is evidence that they are not of excessively complex or fugitive character, and the prospects of success in determining their chemical constitution is encouraging. Such information when obtained will undoubtedly contribute more to human welfare than can now be appreciated.

The proper selection, preparation and conservation of the food supplies of man and of domestic animals is intimately connected with a knowledge of the chemical properties of vitamins. Future modifications of food products will undoubtedly exceed those of the past. A comparison of the foodstuffs of primitive populations with the package products of to-day will give a faint hint of the extent of the improvements which may be expected in the future.

The modification of natural food products for the purpose of conservation and economical preparation for consumption is a field of endeavor which is deserving of unlimited effort. When there is also con-

[1] Presented before the Division of Medicinal Products at the 67th meeting of the American Chemical Society, April 22, 1924.

sidered the possibility of eliminating specific diseases and reducing the prevalence of others by increasing resistance to infections, through a knowledge of vitamins, the importance of research on their chemistry can not be overestimated.

On account of the very small amounts of vitamin required for striking physiological effects, it has been suggested that they are related to enzymes. Acceptance of this view has undoubtedly turned many from the problem, since the possibility of isolating an enzyme appears now to be very remote. Fortunately, the evidence is increasing that vitamins are less complicated structures than enzymes. The work which it is my privilege to report to-day furnishes additional proof that the characteristic physiological activity ascribed to vitamin B resides in a molecule of reasonably simple composition.

Before directing your attention to the work on vitamin B I wish to summarize briefly the status of current chemical studies on the other recognized vitamins.

Vitamin A

Considering first the so-called fat soluble vitamin A, which has been found to be especially abundant in cod liver oil, it is now well established that by saponification of the oil, the activity remains unimpaired in the non-saponifiable fraction. This latter is largely composed of cholesterol. In addition there are present lipochromes, fatty acids and substances which give a characteristic blue violet color when the sample is dissolved in petroleum spirit or similar solvent and a drop of sulfuric acid is added. Drummond and Watson[2] have obtained evidence that in liver oils there is an association between the presence of vitamin A and the power to give the typical color reaction.

In an attempt to isolate vitamin A from the non-saponifiable fraction of cod liver oil, Takahashi[3] obtained a semi-crystalline product by the following procedure. The oil was first saponified with alcoholic potassium hydroxide and insoluble calcium soaps precipitated by addition of calcium chloride. The mixture was then saturated with carbon dioxide, after which the alcohol was removed, and the residue extracted with ether. The ethereal extract was treated with dilute hydrochloric acid and the liberated fatty acids separated from it with the aid of alkaline aqueous alcohol. The ether was then distilled off and the residue dissolved in methyl alcohol. This solution was cooled and the cholesterol which separated was removed by filtration. Additional impurities were eliminated by treatment with digitonin and the final filtrate concentrated to a viscous syrup. This was dissolved in a small quantity of methyl alcohol and cooled to — 20° C. From this solution there separated a semi-crystalline product which, when tested on mice, was active in daily doses of 0.08 milligram. It contained C, H and O but no N. Its properties indicated that it was of aldehydic nature.

These experiments are very encouraging and show that a more intimate knowledge of the chemistry of vitamin A only awaits additional experimental work.

Vitamin C

In regard to the antiscorbutic vitamin C no exhaustive work on its isolation and identification has, so far, been reported. The ease with which it is destroyed by alkalinity and oxidation makes experiments with this vitamin very difficult. Attention should, however, be called to the experiments of Bezssonoff[4] on cabbage juice. His process consists in subjecting cabbages to hydraulic pressure and immediately treating the expressed liquid with neutral lead acetate. The excess of lead is removed from the solution with hydrogen sulfide and the filtered liquid evaporated to dryness at 35° under diminished pressure. The final product is dried over sulfuric acid in a vacuum. There is obtained 2.5 grams of slightly yellowish very hygroscopic powder from each 100 cubic centimeters of the cabbage juice. An apparatus is used which permits all the operations to be conducted in the nearly complete absence of oxygen. The product contains 33 to 46 per cent. of reducing sugars and 52 to 65 per cent. of total sugar. There is present about 7.5 per cent. of ash. It is free of fats and proteins and is active for guinea pigs in daily doses of 0.1 gram.

Recent work by Zilva[5] on the chemical character of the antiscorbutic fraction of desiccated lemon juice has shown that the invert sugar, which it contains, can be eliminated almost completely, without destroying the activity of the solution, by fermenting with yeast in an atmosphere of carbon dioxide. Thus he has obtained a product containing fewer impurities than any potent antiscorbutic so far described.

Vitamin D

The latest announcements of interest in connection with the chemistry of vitamins are those concerned with the recently identified vitamin D. This product is characterized by its power to accelerate the growth of yeast and is probably identical with the "bios"

[2] J. C. Drummond and A. F. Watson, *Analyst*, 47, 341–9 (1922).

[3] K. Takahashi, *J. Chem. Soc.* (Japan), 43, 828–30 (1922); 44, 580–605 (1923).

[4] N. Bezssonoff, *Compt. rend.*, 175, 846 (1922).

[5] S. S. Zilva, *Biochem. J.*, 17, 410, 415 (1923); 18, 182 (1924).

of Wildiers.[6] Three groups of investigators have recently reported the isolation of crystalline or otherwise well-characterized compounds, which greatly promote the growth of yeast. The most surprising of these is the work done at the University of Toronto and reported by W. Lash Miller.[7] According to these experiments an infusion of malt house "combings," when purified by addition of alcohol and the filtrate precipitated with barium hydroxide, gave two products, neither of which was separately active, but a mixture of the two promoted the growth of yeast almost as well as did the original infusion. The fraction which was carried down by the baryta was designated "Bios I" and the one left dissolved was called "Bios II." The outstanding behavior of each was described, as well as their relative distribution in various products. It was later found that Bios II could be divided into two fractions, thus showing the presence of at least three separable constituents, all of which must be present in the medium to accelerate the growth of yeast.

A more recent announcement is that of Eddy, Kerr and Williams,[8] who report the isolation of a crystalline substance having the properties of bios. The essential feature of their method consists in a preliminary purification of autolyzed yeast by Fuller's earth, which removes other substances than bios, followed by the use of colloidal iron hydroxide. This latter carries down the bios, and can later be dissolved, leaving the bios free of contaminating ions. These authors expect to report more fully on their work at the present meeting.

Finally, attention should be called to a paper by Suzuki and Suzuki,[9] in which it is stated that vitamin D was separated from vitamin B by the use of aluminium cream and other precipitating agents.

VITAMIN B

Returning now to studies on the isolation of the antineuritic vitamin B, it should be mentioned that a very complete summary of the experiments made up to 1922 is given by Professor Sherman in his book "The Vitamins."

The original method of Funk, which has been followed more or less closely by the majority of those who have devoted themselves to this problem, consists in extracting the raw material with acidified water or aqueous alcohol. The resulting extract is concentrated and, after removal of extraneous material, the solution is subjected to successive precipitations with such reagents as phosphotungstic acid, silver nitrate, tannic and picric acids. In all cases in which crystalline products were finally obtained they proved to be well-known compounds, which did not possess the physiological properties of the antineuritic vitamin, or else the activity which they exhibited could be accounted for by impurities still present. Recent work following this same procedure is reported by Tsukiye.[10] A gray white powder, curative for hens in doses of about 10 milligrams, was finally obtained. It exhibited great similarity to histidine in most respects except the diazo reaction. As compared with pyrimidine bases and allantoin, it possessed some like properties and others which were different.

A consideration of the general procedure mentioned above shows that the desired separation of the vitamin from the numerous substances with which it is associated depends in the first place upon a fractional solubility in water or alcohol, and secondly upon the formation of insoluble complexes of the vitamin with certain precipitating reagents.

It is apparent that the first step, which depends upon solubility differences, is only slightly selective. Consequently any improvement at this point would be a distinct advantage. Realizing this and knowing of the discovery by Professor John Uri Lloyd that Fuller's earth exerts a selective adsorption of alkaloids, I tested, several years ago, the adsorptive power of this reagent for the antineuritic vitamin, and luckily found that it could be successfully used for separating this vitamin from the larger part of the substances with which it may be associated in solution. The vitamin-Fuller's earth adsorption complex or "activated solid," as I have called it for convenience, undoubtedly contains the vitamin in a purer form than any other product available as a starting point for isolation experiments.

Fortunately the active material can be recovered from its combination with the Fuller's earth by a relative simple procedure,[11] and the concentrated extract thus obtained has, in my opinion, advantages for precipitation experiments far superior to those of extracts prepared in any other way. All my subsequent work has, therefore, been based upon the utilization of this remarkable power of Fuller's earth, and any measure of success that may have been attained is due to this exceptionally favorable initial step of the process. It is interesting to note in this connection that selective adsorption has recently been utilized with great advantage in the purification of insulin, in which case charcoal was used as the adsorbent.

[6] Wildiers, "La Cellule," 18, 313 (1901); Amand, *ibid.*, 21, 327 (1904); Devloo, *ibid.*, 23, 361 (1906).

[7] W. Lash Miller, SCIENCE, 59, 197, 1924.

[8] March 26th meeting of the Society for Experimental Biology and Medicine, New York.

[9] U. Suzuki and B. Suzuki, *J. Chem. Soc.* (Japan), 44, 225 (1923).

[10] S. Tsukiye, *Biochem. Z.*, 131, 124–39 (1922).

[11] Seidell, *J. Am. Chem. Soc.*, 44, 2043 (1922).

Physiological Tests

As mentioned previously, the circumstance which has perhaps retarded most the isolation of vitamins has been the necessity of depending upon physiological tests for controlling the fractionation procedures. In the early days the test for antineuritic activity was made by restricting a bird to a diet of polished rice until symptoms of polyneuritis developed, and then administering the unknown sample and noting the effect. It was later recognized that these curative tests were subject to unaccountable irregularities and many erroneous conclusions had been drawn. Gradually it has become evident that protective tests are much more reliable. In these cases the bird is placed on a vitamin B free diet and simultaneously given, at regular intervals, measured doses of the sample to be tested. A decline in weight indicates that the unknown contains less vitamin than required for maintenance. It has furthermore been found[12] that the indications of this test are even more trustworthy, if the birds are kept on a vitamin-free diet and given such doses of a standard vitamin preparation ("activated solid"), as are just sufficient to prevent loss in weight. When now the standard vitamin is replaced by the sample to be tested, any diminution in vitamin content below that of the standard is promptly and uniformly indicated by a loss in weight. Using pigeons, accurate conclusions as to the activity of a given sample can be drawn within a period of ten days, and in cases where the dose is markedly inadequate, an unmistakable decline in weight occurs within six and sometimes within four days. By this procedure the birds can be used repeatedly for the tests, provided care is taken that no more than moderate losses in weight are permitted. Many of the pigeons used for the tests depicted in the charts which follow have been kept for more than a year on an exclusive diet of polished rice, supplemented only by highly purified vitamin B preparations. It is interesting to note in this connection that as the pigeon reaches old age its vitamin requirement becomes less. Pigeons of three or more years may sustain no loss in weight when receiving only one half the vitamin required to maintain a one-year-old pigeon.

Silver Precipitation

The first precipitant which was used for removal of the active constituent of the vitamin extracts, prepared as above outlined, was silver nitrate.[13] Although the experiments showed that the active material was undoubtedly precipitated, especially by ammoniacal silver nitrate, it was found that a large proportion of the vitamin remained in the liquid. Furthermore, it became evident that inactive material was precipitated simultaneously with the active. Thus, on decomposing the silver precipitate and testing the resulting silver free product, there was no significant increase of activity over that of the original extract used for the precipitation. These unfavorable results finally made it necessary to abandon the silver method.

Picric Acid Precipitation

Of the other reagents which were available, picric acid was selected as the most promising. The conditions for the nearly complete precipitation of the active material have been gradually developed and the resulting crude picrate subsequently separated into two crystalline compounds, one of which is highly active. There has thus been obtained for the first time ample quantities of a well-characterized antineuritic compound, suitable for detailed studies of the chemical structure of this one of the at present recognized vitamins.

A preliminary account of the preparation of the active picrate has been recently published,[14] and it will only be necessary at this time to outline briefly the steps involved and call attention to the evidence on which is based the conclusion that a crystalline compound, possessing the antineuritic properties of vitamin B, has been obtained.

Removal of Potassium Salts from the Vitamin Extract

The crude vitamin extract prepared from brewers' yeast by the Fuller's earth method and used for silver precipitations during more than a year had been tested for activity on numerous occasions and its high potency well established. At the time the experiments with picric acid were begun, it was unexpectedly found that a large proportion of a potassium salt was present in the extract. The source of this was undoubtedly the Fuller's earth, from which it would be displaced by a substitution of bases during the extraction with barium hydroxide. The removal of the potassium from the extract was accomplished as follows.

The ash obtained from an aliquot of the extract was titrated with standard sulfuric acid, using methyl orange as indicator. On the basis of this titration an amount of sulfuric acid, equivalent to the total fixed bases, was added to the main portion of the extract and the solution evaporated nearly to dryness. The residue was digested in 66 per cent. ethyl alcohol and the insoluble potassium sulfate removed by centrifugation.

[12] Seidell, Public Health Reports, 37, 1919–23, June 23, 1922.

[13] Seidell, Public Health Reports, 36, 665–70, April 1, 1921; *J. Am. Chem. Soc.* 44, 2045 (1922).

[14] Seidell, Public Health Reports, 39, 294–9, February 15, 1924.

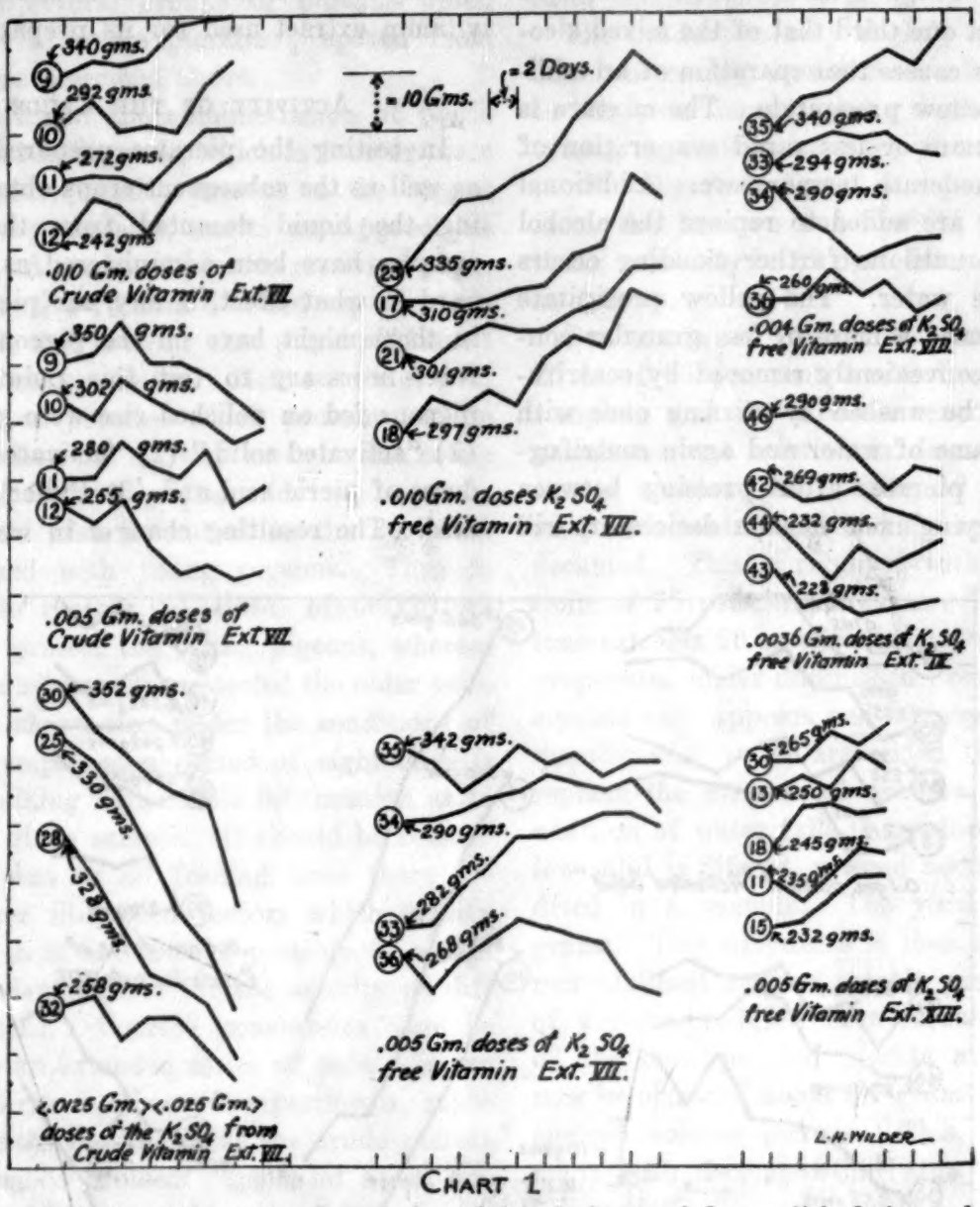

CHART 1

This chart shows the changes in weight of pigeons fed on polished rice and given each second day the specified quantities of vitamin extract, before and after removal of the potassium salts, and also of one sample of the removed K_2SO_4. The figures in circles give the number, and the others the weight of the pigeons at the beginning of the test.

That this procedure exerted no injurious effect on the vitamin is demonstrated by the results in Chart I. An examination of this chart shows that 0.010 gm doses of the crude vitamin extract VII, given on each alternate day, caused pigeons on a diet of polished rice to slowly gain weight. One half this dose was insufficient to prevent the gradual loss in weight of another group. Corresponding doses of the extract from which the potassium salt had been removed gave results indicating increased activity, thus showing that the process for removal of the potassium salt had not caused an appreciable destruction of the vitamin originally present. The potency of three other samples of vitamin extract, freed of potassium salts by the described procedure, is shown by results in the chart. Finally, the inactivity of the removed potassium sulfate is demonstrated by one group of pigeons.

It is to be noted that the pigeons used for the tests recorded in Chart I were of unknown age and had been kept on an exclusive diet of polished rice for some time. It was afterwards found that young pigeons, of one year or less in age, required distinctly larger doses of vitamin to protect them from loss in weight.

PREPARATION OF THE CRUDE PICRATE

Having obtained a highly active vitamin extract, free of potassium salts, the next step was to prepare a picrate of it and determine what proportion of the total active material is present in the resulting compound. After many experiments the following procedure was adopted.

To the concentrated 66 per cent. alcoholic solution of the extract is slowly added, with stirring, an amount of picric acid, dissolved in warm methyl alcohol, approximately equal in weight to the solids pres-

ent in the extract. There is then added a volume of water equal to about one third that of the mixed alcoholic solution. This causes the separation of an additional amount of yellow precipitate. The mixture is then subjected to more or less rapid evaporation of the alcohol at a moderate temperature. Additional quantities of water are added to replace the alcohol from time to time, until no further clouding occurs on addition of the water. The yellow precipitate will then have assumed a more or less granular condition and can be conveniently removed by centrifugation. It should be washed by stirring once with about an equal volume of water and again centrifuging. The washed picrate, after pressing between filter paper and drying in a vacuum desiccator, will usually weigh somewhat more than the solids of the vitamin extract used for its preparation.

Activity of the Crude Picrate

In testing the picrates prepared in this manner, as well as the subsequent crops obtained by evaporating the liquid decanted from the first crop, the samples have been administered as such, without regard to what effect, if any, the picric acid contained in them might have on the pigeons. It was, therefore, necessary to test this point, and groups of pigeons fed on polished rice were given, respectively, (1) "activated solid," (2) "activated solid" plus large doses of picric acid and (3) Fuller's earth plus picric acid. The resulting changes in weight are exhibited

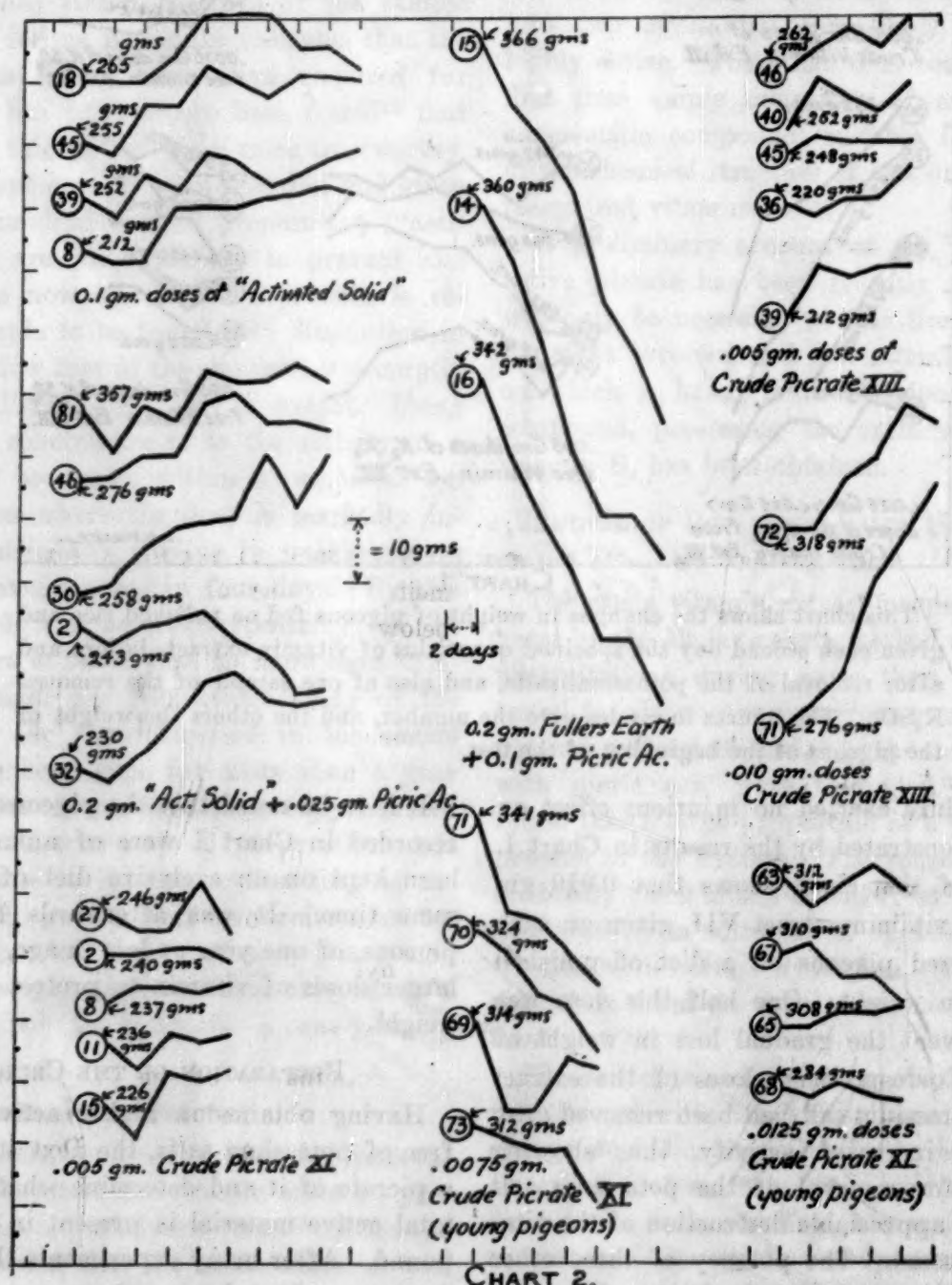
0.1 gm. doses of "Activated Solid"
0.2 gm. "Act. Solid" + .025 gm. Picric Ac.
.005 gm. Crude Picrate XI
0.2 gm. Fullers Earth + 0.1 gm. Picric Ac.
.0075 gm. Crude Picrate XI (young pigeons)
.005 gm. doses of Crude Picrate XIII.
.010 gm. doses Crude Picrate XIII.
.0125 gm. doses Crude Picrate XI (young pigeons)
= 10 gms
2 days

CHART 2.

This chart shows the changes in weight of pigeons fed on polished rice and given each second day the indicated quantities of various vitamin preparations. The figures in circles are the number, and the others the weight of the pigeons at the beginning of the test. Two of the above tests were made with pigeons one year or less in age.

in Chart II. There is also shown in this chart the weight curves of several groups of pigeons which were given doses of crude picrates prepared from vitamin extracts as described above.

It will be noted that the administration of picric acid in doses of 25 milligrams, which is four or more times the maximum quantity present in the largest doses of the active picrates, exerts no appreciable deleterious effect. A group of pigeons receiving picric acid without protective vitamin declined rapidly, thus serving as controls and showing that picric acid itself exerts absolutely no protection. Hence it is evident that in the case of picrates which prevent loss in weight on a rice diet, the activity must be due solely to the base united with the picric acid.

Attention should also be called to the variation in results obtained with young pigeons. Thus in the case of crude picrate XI, doses of 0.0125 gm were required to protect the young pigeons, whereas doses of 0.005 gm adequately protected the older ones.

The chart also shows that under the conditions of the test as here employed a period of eight days is sufficient for obtaining dependable information as to the activity of a given sample. It should be remembered, however, that in all feeding tests there are likely to be minor ill-defined factors which modify the results, and it is not always possible to obtain uniformly concordant figures for the activity of different preparations. Correct conclusions can be drawn only from an extended series of tests. In the present case a large number of experiments, made during many months, indicate that the crude picrate prepared as described protects pigeons of about one year in age from loss in weight on polished rice in doses of approximately 0.010 gm given on alternate days.

The solution separated from the above described picrate, when evaporated, yields further quantities of solid picrates, but these usually fail to protect pigeons in doses of two or three times the protective dose of the picrate which first separates. The solids of the final mother liquor also show a low protection. Approximately quantitative results indicate that about 80 per cent. of the vitamin originally present is retained by the first crop of crude picrate obtained as described.

Fractionation of the Crude Picrates

A superficial examination of the dried yellow granular picrate indicates that it is not homogeneous. Under the microscope there may be seen prismatic needles; bright reddish colored particles and numerous amorphous masses which may or may not show projecting spines. There is apparently more than one picrate present, and the relative amount of each probably depends upon the ratio of picric acid and concentration of alcohol present at the time the picrates separate from solution.

The product is only slightly soluble in water but dissolves readily in mixtures of acetone and water. It has been found that by digestion in acetone containing a small proportion of water the more active portion dissolves first. A separation of the active from the inactive constituents, by means of fractional solubility in 95 per cent. acetone, may be made as follows.

Ten grams of the crude picrate are stirred with 20 cc of 95 per cent. acetone until disintegration is complete and the mixture centrifuged. The supernatant acetone solution is decanted and the picrate stirred a second time, using 10 cc of acetone. The mixture is centrifuged and the second acetone extract decanted. This is repeated with 5 cc and 3 cc portions of 95 per cent. acetone. To the combined acetone extracts 20 cc of water are added and the liquid evaporated under diminished pressure. A yellow precipitate soon appears and increases in amount. Small quantities of water are added from time to time to replace the evaporated acetone. When the further addition of water fails to produce a clouding the yellow solid is filtered, pressed between filter paper and dried in a vacuum. The yield is usually about 5 grams. This procedure is then repeated on the once recrystallized acetone soluble picrate, using amounts of acetone, reduced in accordance with the weight of the once purified picrate available. There will now be obtained about 3.0 grams of twice crystallized acetone soluble picrate. This, as mentioned later, melts with decomposition at a temperature usually below 150°.

The acetone insoluble residue, when recrystallized from warm water or dilute acetone, yields well-formed prismatic needles which melt sharply at 202–3° and after complete dehydration at 206°. An investigation of the identity of this product is being made by Dr. W. O. Emery, of the Bureau of Chemistry.

Activity of the Acetone Soluble Picrate

Physiological tests of the fractions obtained by the above procedure were made on young pigeons of about one year in age. The results are given in Chart III. An examination of this chart shows clearly that the acetone insoluble part of the crude picrate possesses very little if any activity. Doses up to 20 milligrams did not prevent a rapid decline in weight, whereas doses of the acetone soluble fractions as low as 1 milligram exerted an appreciable effect. It is apparent that a fully protective dose of the acetone soluble fraction is about 4 milligrams, which is two and one half times less than the average quantity of the crude picrate required for protection.

Assuming a content of about 50 per cent. of picric

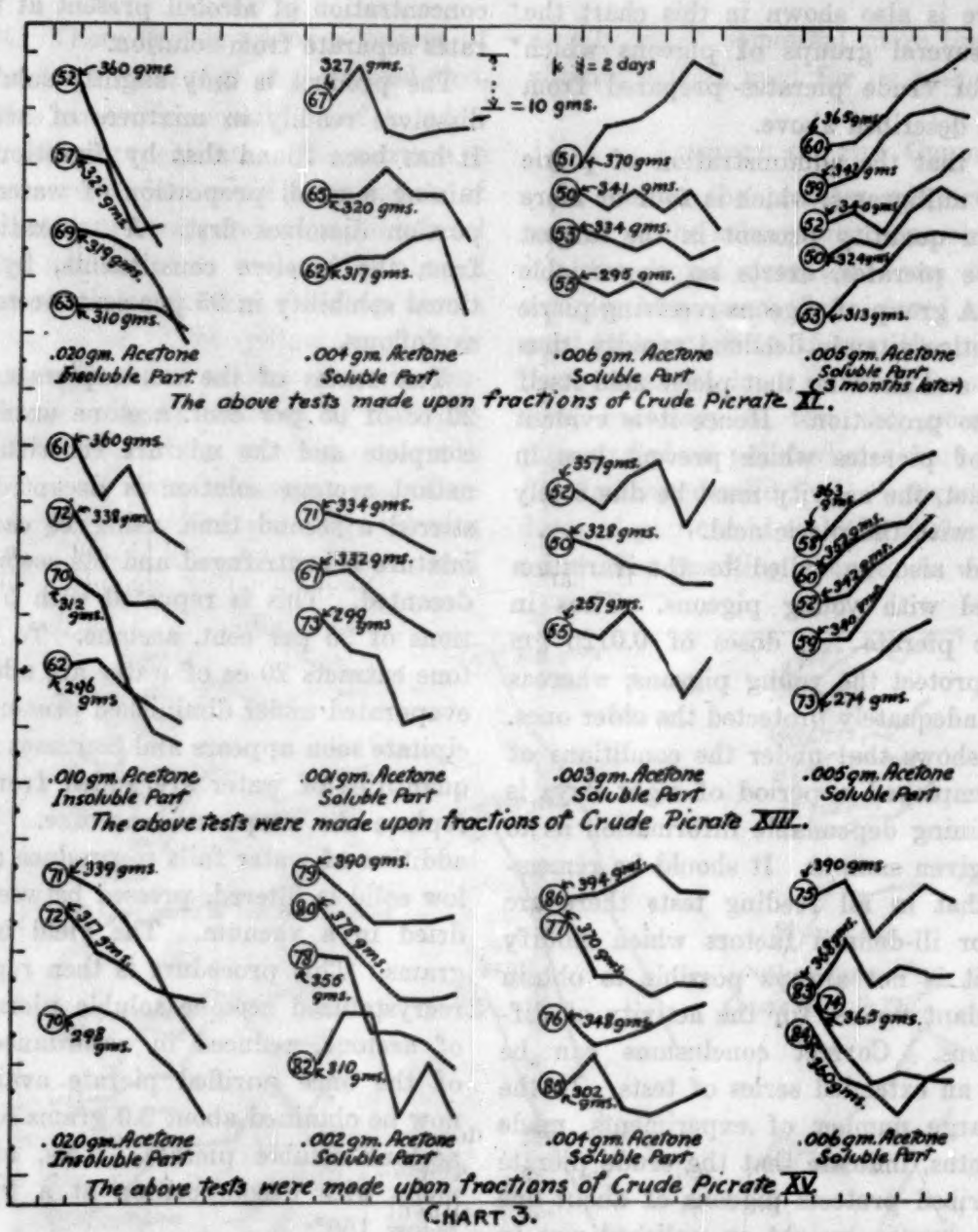

CHART 3.

This chart shows the changes in weight of pigeons of about one year in age fed on polished rice and given each second day the specified quantities of the 95% acetone soluble and insoluble fractions obtained from three samples of crude picrate. The figures in circles give the number, and the others the weight of the pigeon at the beginning of the test.

acid in the active fraction, the daily protective dose, calculated to uncombined vitamin base, would be approximately 1 milligram. For older pigeons probably less than one half this quantity would be sufficient. This is close to the previous figure calculated from nitrogen determination upon purified fractions obtained by the silver method[15] and shows that in both cases a distinctly significant amount of vitamin base is required for protection. It appears improbable, therefore, that the physiological action of vitamin is due to far smaller amounts of superactive substances of the nature of enzymes.

One other point worthy of note in connection with the present tests is that, in one case (see Chart III), a sample of the active fraction lost none of its protective power on being kept for a period of three months. It may, therefore, be concluded that the acetone purified picrate is a relatively stable form of antineuritic vitamin.

THE CHARACTER OF THE ACTIVE PICRATE

The first question which arises in connection with the acetone soluble picrate, obtained as described above, is whether its activity is to be ascribed to the one or probably more bases in combination with picric acid, or to some substance present as an impurity. An analysis of the process by which this final product is obtained indicates that the latter possibility is remote. If, for example, it is assumed that an unknown substance X is present, it will be necessary to ascribe to it exactly the same solubility relations exhibited by the acetone soluble picrate. Although it is possible that a compound, not a picrate, dissolves and sepa-

[15] Seidell, Public Health Reports, 37, 1523 (1922).

rates from solution in exactly the same manner as the picrate here described, it is not at all probable. As has been mentioned in connection with the fractionation process, another picrate (the sharply melting prismatic needles), no doubt closely related chemically to the active one, is almost, if not completely, separated from it by solubility differences in acetone. It would indeed be strange if some compound of an entirely different type should remain associated with only one of these two picrates, throughout the entire series of operations.

The possibility of such an attainment being due to an adsorption appears not to be well founded, since the solid picrate, on which it would be necessary to assume the adsorption occurs, separates from the same clear solution from which the hypothetical substance X is supposed to be subsequently adsorbed. Furthermore, the several crops of picrate which are successively obtained differ appreciably in activity and consequently, if the activity of the earlier crops is due to an adsorbed impurity, the latter crops should also obtain their share of it. The available evidence, therefore, points to the absence of adsorbed physiologically active impurities in the picrate obtained as described.

The question as to whether the recrystallized acetone soluble picrate is free from small amounts of a closely related picrate or degradation product of the active compound is still unsettled. The proper conditions for obtaining well-formed crystals have not been learned. The crystals that are obtained appear as aggregates of thin pale yellow plates with irregular outline. These show indices of refraction[16] of about 1.5 in the alpha direction and 1.8 + in the gamma. There is present, however, in all samples so far obtained a certain proportion of apparently potentially crystallizable material, which has not assumed a definitely crystalline character. This is probably due to the manner in which the crystallization occurs. As mentioned previously, water is added to the acetone solution of the picrate in repeated small quantities during the crystallization until its further addition causes no clouding. It has been found that this addition of water is essential, probably not to supply water of crystallization, since the final product has none, but to yield the proper dilution of acetone. As the solvent evaporates there first appears a yellow cloud which soon collects as a voluminous amorphous mass, throughout which, after a time, glistening facets can be distinguished. The volume gradually contracts and the crystalline appearance of the separated solid becomes more and more pronounced. There evidently takes place a gradual transition from the amorphous to crystalline state, and this process does not go to completion under the conditions which have so far been provided. Although this is to be regretted from the standpoint of accurate characterization of the product by its physical properties, it need not be a serious handicap to the identification of the compound. It is probably that the composition of the amorphous material is essentially the same as that of the crystalline portion, and analytical tests applied to samples containing the two forms should give trustworthy information concerning the identity of the active product.

Determinations of the melting point of the samples give unsatisfactory results since the product decomposes without melting sharply. The decomposition range varies somewhat with different samples but usually begins between 125° and 160° C. After an initial contraction, effervescence without discoloration occurs, and this increases slowly, accompanied by darkening, and ends in a greatly expanded mass of black foam.

The combustion analyses which have been made on the active picrate have not as yet given results from which it has been possible to calculate a satisfactory empirical formula. An approximate determination of amino nitrogen by the Van Slyke method indicated that a part of the nitrogen is present in this form. Tests of the rotatory power of the vitamin extract, before preparation of the picrate, showed an undoubted, although a very small, deviation to the left. Other qualitative tests for various properties and constituent groups have been applied, but an indication of the real identity of the compound has not as yet been obtained.

SUMMARY

There has been a notable revival of interest in the chemistry of vitamins within the past few years. The recent work has led to the isolation of more or less completely crystalline compounds having the properties ascribed to vitamins A, B and D. The evidence now available appears to definitely establish the conclusion that vitamins are not to be classed with enzymes. The physiologically active crystalline products which now for the first time have been isolated make possible intensive studies of the constitution and chemical properties of the several vitamins. Although many years have been required to obtain these elusive compounds in the state of purity now reported, it is probable that their identification will be accomplished in a much shorter time. With the completion of this latter phase of the problem we may confidently look forward to the eventual synthesis of the vitamins and their extensive application to the nutritive needs of man.

ATHERTON SEIDELL
HYGIENIC LABORATORY,
U. S. PUBLIC HEALTH SERVICE

[16] These estimates were made by Dr. E. T. Wherry, of the Bureau of Chemistry, to whom I wish to express my appreciation for his assistance.

WILLIAM MADDOCK BAYLISS—PHYSIOLOGIST

BIOLOGICAL science suffers a severe loss in the death on August 27, 1924, of Sir William Maddock Bayliss, recognized the world over as one of the foremost contemporary physiologists. The term "physiologist," as applied to him, has a very broad connotation, for, like Claude Bernard, whom he so greatly admired, he thought of physiology as nothing less than "the science of life." He had been for some years past professor of general physiology at University College, Gower Street, London, and as a research worker had performed many brilliant experiments. But he was more than a remarkable specialist, for he coupled with this a depth of general insight and a breadth of intellectual horizon which marked him as one of the biological philosophers of the age.

It was the publication of his "Principles of General Physiology" (1915) that brought Professor Bayliss most definitely and prominently before the scientific world. This book professedly dealt with "abstract physiology," and appearing at a time when problems of the war occupied the attention of scientific men its prompt and general recognition could not have been expected. However, even under these unfavorable circumstances, the volume, packed as it is with source materials, historical information and hints on technique and method, made a profound impression and was characterized as "Principia Physiologica." Bayliss Clubs were formed, at least in America, and there was a sense of having reached objectivity in the science of living substance.

"Principles," which reached its third edition in 1920, is a unique volume occupying a unique place. Most of the problems considered in it are common to man and to all living creatures, animal or plant. It is a masterly presentation of those physical and chemical processes which underlie the dynamic changes known as the phenomena of life. It is common to neglect reading those articles which do not appear to concern one's own particular domain of science. Just here is where the uniqueness of Professor Bayliss and his work show up sharply. He saw the need and took the trouble to work in many fields, often not biological, and here he uncovered materials of fundamental import to his subject. He arranged these facts in such a way as to produce a work that is of much use to all who have interest in science.

It need hardly be said that Professor Bayliss addressed himself to a very difficult subject when he chose to discuss the basic processes which intervene in vital phenomena. He had to blaze new trails and make tentative judgments on many very unsettled questions. The admirable way in which he has handled these problems must have appealed to all his readers. His point of view in reference to the frontier of science may be illustrated by a quotation from the remarkable preface of this book, which is so much an autobiography that it has to be given first consideration if one writes anything about its author. He says:

> Truth is more likely to come out of error, if this is clear and definite, than out of confusion, and my experience teaches me that it is better to hold a well-understood and intelligible opinion, even if it should turn out to be wrong, than to be content with a muddle-headed mixture of conflicting views, sometimes miscalled impartiality, and often no better than no opinion at all. . . . It is not going too far to say that the greatness of a scientific investigator does not rest on the fact of his having never made a mistake, but rather on his readiness to admit that he has done so, whenever the contrary evidence is cogent enough.

Sir William was born in 1860, the only son of an iron manufacturer of Wolverhampton, England. He was of short stature, did not have a rugged constitution and was rather reticent in his disposition. For a while he engaged in his father's business with a view to learning it, but was not happy there. Being later apprenticed to a physician, he found that work much more to his liking and entered University College, London, in 1881, apparently with the desire of pursuing medicine. He came under the tuition and influence of Burdon-Sanderson, then professor of physiology. The following year he obtained a university scholarship in zoology and continued his studies. Sanderson was called to Oxford in 1883. After some discouragements and disinclinations in reference to certain medical subjects Bayliss seems to have concluded to give up the notion of becoming a physician and to have decided to devote himself to physiology. He followed Sanderson to Oxford in 1885 and from there took his degree in 1888. Returning to London he established a private laboratory in his father's house at Hampstead Heath. Here he did a great deal of reading and considerable experimenting but apparently gave little thought to publishing reports of his work. He associated himself with Schafer who had succeeded Sanderson at University College and with whom he had studied after Sanderson went to Oxford. About this time E. H. Starling, who was instructor in physiology at Guy's Hospital, also began research work in Schafer's laboratory. Bayliss and Starling became very close friends and collaborators. This happy cooperation has continued through the years and bore abundant fruitage in the many papers along the well-known lines: electrical phenomena of the heart, the regulation of the circulation, the movements of the intestines, pancreatic secretion and the action of the hormones.

Bayliss married his colleague's sister, Gertrude E. Starling, in 1893.

When Schafer was called to Edinburgh and Starling was appointed to succeed him in 1899, Bayliss cast in his lot with his friend and brother in the department at University College. He became assistant, then assistant professor and finally professor of general physiology. Probably it was a very fortunate thing that Professor Bayliss was prevailed upon to enter the routine of teaching. Had he been allowed to continue in his own private laboratory, without any such demands shaping his interests, he doubtless would have made many important and critical experiments, but it is doubtful if "Principles" would ever have come from his pen. In 1910–11 during the illness of Professor Starling and again while he was engaged in war duties, 1915–19, Professor Bayliss acted as head of the department. For a time he was dean of the faculty of science. He was chairman of the Shock Committee of the Medical Research Council, a member of the Chemical Warfare Medical Committee and of the Research Committee of the Food Investigation Board. In 1903 he was elected fellow of the Royal Society and was a member of the council in 1913–15. He is well known as joint editor of *The Biochemical Journal* and just before his illness had assumed editorship of *Physiological Abstracts.*

Following the war, when men turned again to take up the threads of science for science sake, the recognition of Professor Bayliss came promptly. Among other honors received, the Copley Medal, which is the greatest distinction within the gift of the Royal Society, was bestowed on him in 1919, he was showered with honorary degrees and was knighted in 1922. Within the last few years he has published several books and monographs of note. The topics include: the nature of enzyme action, intravenous injection in wound-shock, the colloidal state in its medical and physiological aspects and the vaso-motor system, to name the more important. These volumes are based largely on research work carried out by himself and his colleagues. In all his writing there is exhibited a clearness of diction and a directness and fairness of judgment in reference to conflicting evidence on difficult problems that cause his books to be much sought in any library. He was the very embodiment of friendliness and cooperation. In his researches he concerned himself with what has been termed "the infinitely little" and in his personal relations he appreciated the untold value of "small things." His life and work exemplify the supreme effectiveness of that casual, quiet, simple and unassuming way of doing things that marked his manner.

STANFORD UNIVERSITY W. R. MILES

SCIENTIFIC EVENTS

MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE tentative program for the coming annual meeting of the American Society of Mechanical Engineers, to be held in New York from December 1 to 4, has been announced. The first day of the meeting has been set aside for council meeting, local sections conferences and technical committee meetings. The technical sessions start Tuesday morning, December 2, and will last through Thursday afternoon. While the program is well balanced in that it touches on all phases of mechanical engineering, it is noteworthy in the fact that there are several sessions with papers of importance and value to members of the society who are interested in the engineering problems of the machine shop.

On Tuesday morning the session devoted to research in machine design and operation will furnish the opportunity for the presentation of various methods of measuring hardness. J. O. Keller, the author of the paper, spent the summer in a series of investigations in which he made hardness measurements by the various known methods, tensile tests, machineability tests and magnetic analyses of pieces of the same material subjected to different heat treatments. His results will include a report of measurements by the Herbert pendulum hardness tester which is a comparatively novel device in this country. At the same session a research committee on metal springs will present a progress report. Although this committee has been organized for a short time it has set up a program and is ready to seek financial support for its research.

At the general session on Tuesday morning R. Eksergian will present a mathematical analysis of strength and proportions of wheels, wheel centers and hubs. This paper will bring a large amount of data to the designing engineers.

On Tuesday afternoon there will be a session devoted to general machine-shop practice with papers on the effect of inaccuracies of gear teeth on mechanical springs, and on ruling line standards by the application of light interference. The paper on inaccuracies in gear teeth was prepared as a thesis at Leland Stanford University by L. J. Franklin and Charles Smith. J. K. Wood, who wrote the paper on mechanical springs, is chairman of the special research committee on this subject and in the paper he presents the results of long experience in designing springs and gives four new formulas for this purpose. The last paper at the session by C. G. Peters and H. B. Lewis is a joint production of the Brown & Sharpe Manufacturing Co. and the Bureau of Standards.

On Wednesday morning a collection of papers on the theory of lubrication will be presented. Lieutenant Commander L. N. Linsley, U. S. N., will present the results of an investigation of critical bearing pressures which he made while taking graduate work at Johns Hopkins University. H. A. S. Howarth's paper on lubrication is a supplement to the paper he presented at the 1923 annual meeting. Louis Illmer's contribution on high-pressure bearing research completes the session.

As the early work in the development of management science was a product of the machine-shop under the leadership of Dr. Taylor, machine-shop men will undoubtedly be interested in Frederick W. Taylor's paper on shop management originally given to the society in 1903 and now presented again by Morris L. Cooke for further discussion. This will take place on Thursday morning, December 4.

On Thursday afternoon there will be two papers which treat of different phases of production control. George D. Babcock will state principles of production control which he has applied to the manufacture of tractors. Ralph E. Flanders will deal with the design, manufacture and production control of a standard machine. In his work Mr. Flanders has been dealing with the problem of reducing manufacturing overhead expense under conditions of fluctuating rates of production.

An innovation at the coming annual meeting is the insertion of two lectures, one on Tuesday afternoon at 4:30 and one on Thursday afternoon at 4:30. The Tuesday lecture will deal with an economic question of interest to engineers and the Thursday lecture will be an interesting presentation of scientific research also of interest to the engineering profession. The time for these two lectures has been set for 4:30 to permit all the members who have been attending the sessions previous to these lectures to be present.

MEETING OF THE METRIC ASSOCIATION

THE Metric Association will hold its annual meeting in Washington, D. C., on December 29 and 30. A program of special interest to manufacturers, merchants and educators is being arranged. George F. Kunz, president of the Metric Association, will preside. Among others scheduled to speak are Arthur E. Kennelly and Alexander McAdie, of Cambridge, Mass.; Theodore H. Miller, F. L. Roberts and Howard Richards, of New York; Charles L. Parsons, S. J. Macfarren and G. H. Paine, of the Columbia Section of the Metric Association, and representatives of the government departments interested. Experts in several industries are to hold conferences in connection with the meeting.

An educational exhibit will be on display during the meeting and also throughout the meeting of the American Association for the Advancement of Science. Modern methods of teaching metric weights and measures will be demonstrated and the educational booklets, rulers and other devices will be considered.

A "weights and measures" luncheon will be held on Monday, the twenty-ninth, at 1 P. M., at the New Willard Hotel. The convention will close with a metric dinner at the New Willard Hotel on Tuesday evening, December 30. Men and women are invited to take part in the entire program. Federal, state and municipal departments and all organizations interested in international standardization are requested to send representatives. Programs, metric literature, etc., may be secured from the Metric Association, New York City.

HOWARD RICHARDS, *Secretary*

ACTIVITIES OF THE ILLINOIS GEOLOGICAL SURVEY

THE Illinois Geological Survey has continued its usual investigations during the past summer, bearing on the occurrence of oil, the correlation and resources of its coal beds, systemic stratigraphy, geologic quadrangle mapping, and the paleobotany of the "coal measures," and in addition cooperated with the United States Geological Survey in an extensive topographic mapping program.

Some of the new features of the Illinois Geological Survey's program have included: (1) the detailed stratigraphy of the Silurian of northern Illinois by Professor T. E. Savage, of the University of Illinois; (2) the chemical study of the oil field waters of the state under the direction of Mr. Gail F. Moulton, formerly assistant professor of geology at the University of South Dakota and associate geologist of the U. S. Geological Survey; (3) laboratory sedimentation studies of the Chester series by Mr. J. E. Lamar, who has made a field study of the series and collected systematically a set of some 2,000 specimens; and (4) a field and laboratory investigation of the state's molding sand resources by Mr. Max Littlefield of the University of Iowa in cooperation with the foundry laboratory of the Engineering Experiment Station of the University of Illinois.

The generous appropriation of the last legislature for topographic mapping amounting to $100,000 for the biennium, with an equal allotment from the Federal Survey, has greatly stimulated the mapping program, and it is anticipated that by the close of the biennium next June 30, some 4,500 square miles of additional territory will have been sketched, including the revision of the maps of Chicago and vicinity.

LECTURES BY INDUSTRIAL FELLOWS OF MELLON INSTITUTE

THE following course of lectures by specialists engaged in research in the Mellon Institute of Industrial Research of the University of Pittsburgh will be given throughout the first and second semesters of the university year 1924–1925, on Monday afternoons at 4:30, in the Fellows' Room of the institute. Each discourse will be one hour in length and will deal with raw materials, manufacturing processes, properties and uses of the techno-chemical products scheduled for discussion.

The lectures are open to the membership of the institute, to interested faculty members and qualified students of the University of Pittsburgh, and to teachers of chemistry and chemists in the Pittsburgh district.

October 6, Insecticides and fungicides, Dr. O. F. Hedenburg.
October 13, Matches, Dr. E. E. Marbaker.
October 20, Fertilizers, Mr. H. H. Myers.
October 27, Portland cement, Mr. Tracy Bartholomew.
November 3, Metallurgical refractories, Mr. M. C. Booze.
November 10, Heat-insulation materials, Mr. R. H. Heilman.
November 17, Corrosion preventives, Mr. C. R. Texter.
November 24, Wrought iron, Dr. B. B. Wescott.
December 1, Protected metals, Dr. J. H. Young.
December 8, Enameled cast iron and sheet steel, Mr. J. E. Hansen.
December 15, Galvanized metal ware, Mr. W. G. Imhoff.
January 5, Salt, Mr. C. C. Kesler.
January 12, Inks, Dr. F. F. Rupert.
January 19, Wood preservatives, Dr. A. M. Howald.
January 26, Petroleum products, Dr. W. A. Gruse.
February 2, Wood chemicals, Mr. R. F. Remler.
February 16, By-product coke, Mr. O. O. Malleis.
February 23, Rubber, Mr. H. W. Greider.
March 2, Cotton textiles, Mr. E. R. Clark.
March 9, Cellulose esters, Dr. W. F. Henderson.
March 16, Sugar, Dr. D. K. Tressler.
March 23, High explosives, Dr. H. L. Cox.
March 30, Edible gelatin, Dr. T. B. Downey.
April 6, Cereal products, Dr. H. A. Kohman.
April 13, Packed foods, Mr. E. R. Harding.
April 20, Official drugs, Dr. A. W. Harvey.
April 27, Newer medicinal agents, Dr. L. H. Cratcher.
May 4, Perfumes, Dr. E. H. Balz.

SCIENTIFIC NOTES AND NEWS

THE French Institute has awarded triennial Osiris prizes of the value of 100,000 francs to Dr. Charles Fabry, for the invention of his interferometer and to M. Jean Richepin, the poet. Dr. Fabry, professor of physics at the University of Paris, is now lecturing at the Massachusetts Institute of Technology.

PROFESSOR E. C. KENDALL, who is in charge of the chemical division of the Mayo Foundation of the University of Minnesota, has been appointed the Chandler lecturer, and will receive the Chandler Medal at a meeting to be held next February.

THE Royal Institute of Scientific Industrial Research of Sweden has awarded its gold medal of the first class to Johannes Ruths, for his invention of the Ruths steam accumulator. This is the first time the medal has been awarded.

THE twenty-fifth anniversary of Professor G. Jelgersma's incumbency of the chair of nervous and mental diseases at the University of Leyden was celebrated by the presentation of his portrait and addresses by twelve speakers representing the universities and medical societies of the Netherlands.

PROFESSOR EDOUARD BRANLY, the French pioneer of radio-telegraphy, celebrated his eightieth birthday on October 22.

DR. JOANNIS, professor of chemistry at the University of Paris, recently retired.

STEPHEN MOULTON BABCOCK, inventor of the "Babcock Test" for determining the amount of butter fat contained in milk, and formerly professor of agricultural chemistry at the University of Wisconsin, recently celebrated his eighty-first birthday.

CLINTON N. LAIRD, professor of chemistry at Canton Christian College, Canton, China, is spending a year, while on leave of absence, at the School of Hygiene and Public Health of the Johns Hopkins University.

GALO W. BLANCO has left his position as chief research chemist for the Riordan Pulp Corporation, Ontario, to take charge of Research on Viscose at the DuPont Fibresilk Company, Buffalo, N. Y.

LAURA I. MCLAUGHLIN, of the University of Chicago, has joined the staff of the bureau of home economics of the United States Department of Agriculture as nutrition chemist.

ROY A. LEWIS, general manager of the Bethlehem Steel Company, Bethlehem, Pa., has joined the staff of lecturers at Lehigh University. Winthrop O. Hearsey, superintendent of the service department of the same company, has also become a member of the staff of lecturers.

PROFESSOR HOWARD ECKER, head of the department of chemistry at the Ohio Mechanics Institute, is now in charge of research for the Johnston Paint Co., Cincinnati, Ohio.

DR. JOHN ALBERT KEY has left Baltimore to take

charge of research work at the Shriner Hospital for Crippled Children, St. Louis.

During the past season the members of the staff of the Roosevelt Wild Life Forest Experiment Station of the New York State College of Forestry at Syracuse have been engaged in field studies as follows: Dr. Charles E. Johnson continued his study of the Adirondack beaver, Dr. A. O. Gross has studied the status of the ruffed grouse in the lower Hudson Valley and Mr. B. A. Scudder has studied the Adirondack deer situation.

Dr. Preston E. James, assistant professor of geography at the University of Michigan, recently returned from field studies in Trinidad, British West Indies.

Professor J. Howard Allison has returned to his work at the University of Minnesota after a year studying forestry in Sweden, as a fellow of the American-Scandinavian Foundation.

David J. Price is on leave of absence for several months from the division of development work of the U. S. Bureau of Chemistry, to carry out some special engineering studies at the Pennsylvania State College.

Dean C. E. Seashore, of the University of Iowa, is spending six weeks beginning on November 1 in visiting colleges and universities in the west for conferences with faculties in the interest of the gifted student project of the Division of Educational Relations in the National Research Council.

Professor Ralph H. McKee, of Columbia University, left on November 1 for Italy, Poland and France. He will return the latter part of December.

Dr. S. O. Fladness, of the U. S. Bureau of Animal Industry, has left for Mexico City, where he will take up his work as agricultural commissioner from the United States on November 1. He will cooperate with Mexican agricultural experts in putting the agricultural relations of the two countries on a sound economic basis, and will represent the U. S. Department of Agriculture in all matters involving the interests of the United States.

Dr. Charles C. Adams, director of the Roosevelt Wild Life Forest Experiment Station of the New York State College of Forestry at Syracuse, spent July, August and September in visiting the national forests and national parks of the southwest. Special attention was given to wild-life problems and the policies of the national parks and the national forests.

Dr. A. V. Hill, professor of physiology at University College, London, will deliver the third Harvey Society Lecture at the New York Academy of Medicine, on Saturday evening, November 15. His subject will be "The recovery process after muscular exercise in man."

Professor Charles de la Vallée-Poussin, of the department of mathematics of the University of Louvain, Belgium, recently delivered two lectures at the University of Michigan.

Dr. I. M. Kolthoff, of the University of Utrecht, Holland, who is visiting the United States under the auspices of the University of Michigan, lectured at the university on October 16 on "The use of different electrodes in neutralization reactions."

Dr. Edward F. Armstrong, president of the Society of Chemical Industry in England, spoke at Yale University on the "Basis of development in chemistry" on October 23.

Courses on human phylogeny and on ontogeny are being given in the United States National Museum by Dr. Aleš Hrdlička, on Monday and Friday afternoons.

E. F. Burchard, of the U. S. Geological Survey, recently addressed The Bag and Hammer, a geological society with a membership recruited from the department of geology at the University of Cincinnati. The subject of the lecture was "The geology of the Birmingham, Alabama, iron district."

J. E. Spurr, editor-in-chief of the *Engineering and Mining Journal-Press*, New York, delivered three lectures on ore deposits, at the University of Toronto, on October 29 and 30. These lectures were given under the auspices of the department of geology of the university, two of them being class lectures and the other an evening lecture on "Ore magmas" which was attended by members of the Toronto branch of the Canadian Institute of Mining and Metallurgy.

The Henry Ward Beecher lectures at Amherst College will be given by Professor James H. Breasted, director of the oriental institute at the University of Chicago. The series will consist of four lectures, to be given on November 17, 18, 19 and 20.

At a joint meeting of the Washington Academy of Sciences and the Philosophical Society of Washington, held at the Cosmos Club, Washington, on November 1, Professor H. N. Russell, of Princeton University, delivered an address on "Recent advances in our knowledge of the interior of the stars."

The inaugural address of the president of the Association of Economic Biologists was delivered on October 24, by Dr. F. A. E. Crew, director of the Animal Research Station, Edinburgh, at the Imperial College of Science and Technology, England.

The General Electric Company has appropriated $25,000 for a memorial fund for Union College in memory of Dr. Charles P. Steinmetz, the company's chief consulting engineer, who died a year ago. The income from this fund will be used to provide four annual scholarships.

THE contract has been let for the erection of a statue in Georgia to Dr. Crawford W. Long, whose name is important in the history of anesthesia. The statue of marble, costing about $9,000, will be completed not later than December 1, 1925.

A TABLET was unveiled on October 5 by the Paris Academy of Sciences in commemoration of the mathematician, Charles Hermite, at Dieuze, his birthplace.

DR. MORRIS B. MILLER, emeritus professor of surgery in the graduate school of medicine of the University of Pennsylvania, died on November 5, at the age of fifty-seven years.

DR. ROBERT PEEL LESLIE, Ph.D. (Toronto), of New York City, well-known pharmacist and head of Leslie & Co., Inc., died on October 31, at the age of forty-seven years.

DR. EDOUARD G. DEVILLE, director-general of surveys in the Canadian Department of the Interior, and author of "Astronomic and geodetic calculations" and "Photographic surveying," died on September 21, aged seventy-three years.

DR. SANTIAGO ROTH, head of the department of paleontology in the Museo de La Plate, Argentina, died on August 4.

DR. E. O. FENZI, of Italy, the well-known horticulturist and introducer of the alligator pear into California, died on November 6 in his eighty-first year.

DR. G. PRUVOT, professor of zoology and comparative physiology at the University of Paris and formerly director of the Marine Zoological Laboratories at Banyuls-sur-Mer, has died.

LADY TEALL has presented to the Sedgwick Museum, of the University of Cambridge, the collection of rocks and rock-slices made by her late husband, Sir Jethro Teall, Sc.D., St. John's College. The collection contains numerous slices described and figured by Sir Jethro in his work, "British Petrography," and in a number of his published papers.

NEGOTIATIONS are expected to be completed shortly whereby the garret in Heathfield Hall, Handsworth, in which James Watt conducted the experiments which led to the development of the steam engine, will be brought bodily to London to be perpetuated in the South Kensington Museum. Watt first went to Heathfield Hall in 1768. After his death the room in which he worked remained locked for many years, and his tools and benches have been undisturbed.

ACTING SECRETARY HOWARD M. GORE, of the U. S. Department of Agriculture, announces that the conference on utilization of forest products called by the late Secretary Wallace for November 19 and 20 will not be postponed. Secretary Wallace regarded waste reduction as one of the most important phases of forest conservation and expected much to be accomplished by the forthcoming conference. The department will commemorate his great service to forestry by carrying out the conference as he planned.

AT the annual meeting of the American Public Health Association, held in Detroit from October 20 to 23, the following officers were elected: *President,* Henry F. Vaughan, Detroit; *vice-presidents,* Drs. Oscar Dowling, New Orleans; Daniel A. McClenahan, Hamilton, Canada, and Powhatan S. Schenck, Norfolk, Va.; *treasurer,* Louis I. Dublin, New York, and *secretary,* Mr. Homer N. Calver, New York.

THE Institution of Electrical Engineers held its first meeting of the 1924–25 session on October 23, when the retiring president announced that the council had made a gift of 100 guineas to the Cavendish Laboratory, Cambridge, as an appreciation of the work done there by distinguished physicists. Dr. A. Russell presented the awards made by the council for papers read during the previous session. W. B. Woodhouse, the new president, then took the chair, and called on Ll. B. Atkinson to propose a vote of thanks to the retiring president, which was seconded by J. S. Highfield, and passed with acclamation, Dr. Russell replying.

THE following lectures are being given at the New York Botanical Garden on Saturday afternoons at 3 P. M.: November 1, "The rock garden," Dr. E. B. Southwick; November 8, "The hardy chrysanthemums," Mr. K. R. Boynton; November 15, "The hemlock grove," Dr. H. A. Gleason; November 22, "The pinetum—The collection of evergreen trees," Dr. N. L. Britton; November 29, "The geology of the New York Botanical Garden," Dr. Arthur Hollick.

THE following public lectures have been given this fall at the Brooklyn Botanic Garden: September 21, "Asters and other herbaceous perennials," H. E. Downer, horticulturist, Vassar College; September 28, "Waterlilies," Charles L. Tricker, horticulturist; October 5, "Cannas," Louis Wintzer, of the Conard and Jones Co.; November 3, "The effect of electricity on the growth of plants," Dr. V. H. Blackman, professor of plant physiology and pathology, Imperial College of Science and Technology, London.

AT the October meetings of the Astronomy and Physics Club of Pasadena the programs were as follows: October 3, "Relativity," Professor A. S. Eddington; October 10, "Is the Compton effect a real effect?" Professor E. C. Watson; October 17, "Modern dynamics," Professor Geo. D. Birkhoff; October 24, "The constancy of the total photoelectric effect in sodium with temperature," R. C. Burt; October 31, "Planetary radiation," Dr. S. B. Nicholson.

The National Museum of Wales at Cardiff has received from Sir William Reardon and Lady Smith a further sum of £5,000, bringing their total contribution to £15,000.

The American Society for Clinical Investigation has founded a journal to be called the *Journal of Clinical Investigation*, and Dr. G. Canby Robinson, dean-elect and professor of medicine at Vanderbilt University, will be editor-in-chief. The new journal has been made possible by a grant to the society by the Rockefeller Institute for Medical Research. The first issue appeared in October.

UNIVERSITY AND EDUCATIONAL NOTES

Harvard College is the beneficiary of one half the estate of George True Nealley, of New York, and the National Academy of Sciences and the National Geographic Society divide the other half equally. The value of his estate was not made known.

It is announced that the University of Pittsburgh has completed plans for the erection of a fifty-two story building, 680 feet high, to be the center of the university activities.

A new group of four buildings at Western University, London, Ontario, which has cost £300,000, were formally opened on October 23. ducats?

A celebration commemorative of the centennial of the foundation of the Medical College of the State of South Carolina took place at Charleston on November 12 and 13.

The statutes of the University of London have been amended to allow the university to confer the degree of bachelor of pharmacy.

Dr. L. W. Taylor, of the University of Chicago, has been appointed head of the department of physics at Oberlin College, to take the place of Professor S. R. Williams, who has resigned.

Wilfred Eldred, associate in the food research institute of Stanford University, has been appointed to a research professorship in the University of Washington.

Dr. Harold St. John, of the department of botany at the State College of Washington, has been promoted to be associate professor of botany and curator of the herbarium.

Dr. Glenn E. Cullen, associate professor of research medicine at the University of Pennsylvania, has been appointed professor of biochemistry in the medical school of Vanderbilt University. Dr. Cullen will be in Europe for a year at Rigs Hospital, Copenhagen.

Dr. Thomas Grover Orr, a physician of Kansas City, has been appointed head of the surgical department of the school of medicine at the University of Kansas.

Dr. Basil Graves, curator of the Royal Westminster Ophthalmic Hospital, has been appointed clinical lecturer and special instructor in charge of the department for microscopy of the living eye in the department of ophthalmology of the graduate school of medicine at the University of Pennsylvania, for a period of three months from January 1, 1925.

Dr. A. T. de Mouilpied, of the British Dyestuffs Corporation, has been appointed professor of science at the Royal Military Academy, Woolwich, in succession to Professor J. Young.

Dr. Alfred Kuhn, professor of zoology at the University of Göttingen, has declined the offer of the professorship of zoology and comparative anatomy at Munich.

DISCUSSION AND CORRESPONDENCE

THERMOMETER SCALES

Apropos of the discussion on thermometer scales it may be worth while to consider some points generally ignored. As far as the people at large are concerned practically everybody is familiar with the relations between the Fahrenheit scale and the temperatures, and it would be most difficult and confusing to them to make a change.

But apart from that, the ideal thermometric scale is far from the centigrade type, at least for those having to do with meteorological statistics. The centigrade is extremely defective in that its degrees are so large that exact work requires decimal fractions to be tabulated, and it has an arbitrary zero requiring plus and minus signs to indicate degrees of temperature. One reason why the Fahrenheit scale is better is that its degrees are so much smaller.

The ideal thermometer will have its scale running all one way, eliminating plus and minus signs, and its degree divisions small enough to require at most only one decimal point in tabulating fractions. The only instance I have come across in which these points are recognized is the scale invented by Louis De Lisle de la Croyère about the end of the 18th century, probably described in the Journal of the Hydrographic Department of the Russian navy, vol. VII, pp. 537–542, 1849 (which I have not seen), and used in the appendix to Krashenninikoff's "History of

Kamchatka" in 1768, or earlier, since this issue is not the first of that work. If we are to have a change of scale let it be to something less objectionable than the centigrade form.

WM. H. DALL

NOTE ON CELLOBIOS AS A DIFFERENTIATING SUGAR FOR CERTAIN BACTERIA

THROUGH the kindness of Dr. Wise, of the New York State College of Forestry, the writer was recently enabled to test the fermentative powers of a number of strains of bacteria of the colon-aerogenes group on the rare sugar known as cellobios. This disaccharide is derived by the acetolysis of cellulose (which yields the octacetate) followed by the removal of the acetyl groups.

The studies so far made indicate that this sugar may be of definite assistance in differentiating members of the genera Escherichia and Aerobacter. Particularly interesting is the fact that certain strains of *Escherichia neapolitana* can be separated into two groups by the use of this sugar; one group fermenting it with very abundant gas production and the other failing to act on it at all.

Further studies on the use of this sugar in bacteriological work are in progress, and bacteriologists having stock cultures of the colon-aerogenes group are invited to submit them for tests with the sugar.

Although this sugar has heretofore seldom been prepared in any considerable amounts, and is not now available in the market, should the demand arise it could doubtless be supplied by certain concerns, since the raw material from which it is prepared (cotton cellulose) is cheap and abundant.

HENRY N. JONES

SYRACUSE UNIVERSITY

COLOR INDICATORS FOR BLIGHT DISINFECTANTS

ONE of the serious practical difficulties involved in control of fire blight (due to *B. amylovorus*) in the orchard lies in securing thorough prophylactic treatment of the lesions after removal or scarification of diseased tissue. This difficulty is, of course, intensified when the treatment must be in the hands of untrained fruit-growers or hired help. Even when the affected tissues are completely removed the sterilization of the remaining exposed tissues is frequently careless and defective. Consequently, any device that will aid in securing thoroughness in this step can not but help make the whole treatment more effective.

Careful check on the thoroughness of the application of the mercury solution is difficult because of its lack of color. The writer has tried several coloring materials and at the suggestion of Professor Patton, Experiment Station chemist, fuchsin red and methylene blue were used. Fuchsin red has proved particularly satisfactory. Added to the Reimer-Day mercury and glycerine solution it has imparted a pronounced color, permitting the operator to detect any small untreated surface and to tell at a glance whether all the cut tissues in the tree have been treated. Field observation has not indicated any diminution in the effectiveness of the material, and the treatment because of the greater thoroughness becomes more effective.

In addition, because the operator is not forced to retrace his steps to make sure that a given wound has been sterilized, time and material is saved.

It should be noted that no laboratory tests of this material with the dye added are available at present, and this communication is based on field observation.

H. A. CARDINELL

MICHIGAN AGRICULTURAL COLLEGE

ARIZONA RUINS

IN the course of a recent prospecting trip in the neighborhood of Clifton, Arizona, I had the opportunity to visit some prehistoric ruins. These consisted of, apparently, dwellings and storehouses built under overhanging cliffs. The storehouses were formed of three adobe walls reinforced with wickerwork. The fourth wall at the back was the natural face of the cliff. Slight excavations disclosed the small Indian corn-cob and several types of seed-pods unknown to me. Excavations on the dwelling platform in front of the storehouses, which were some six feet square, disclosed pot shards, remains of grass sandals and some fragments of basketry. The walls of the cliffs outside of the smoked surfaces showed a number of disconnected outline paintings. These were in red or green and in some instances combinations of the two colors. I suspect that the green pigment was some copper mineral pulverized but had no facilities for analysis. Subjects were varied. They included geometrical designs, men, mountain goats, centipedes and fish. They ranged from a foot to two feet in length and the same in height. I made sketches in pencil of many of them of which I would gladly send copies to any person interested as well as any further details desired. Messrs. Thompson and Lenard, the owners of the Spur Cross ranch on which the caves are located, assure me that there are other caves in the vicinity which were not visited because of lack of time and further that no archeologist has ever visited the district. It seems to me worthy of exploration.

R. S. EVERIT

BARRE, MASS.

SPECIAL ARTICLES

THERMAL EXPANSION OF WOOD

Up to the present time very little work has been done on the thermal expansion of wood. Villari[1] made measurements on several varieties in 1868, and Glatzel[2] worked on the longitudinal expansion in 1877. Glatzel dried his specimens in a vacuum at room temperature. His results show a continuous change in coefficients of expansion for consecutive heating and cooling. There was also as high as 35 per cent. difference between the coefficients determined from the heating and cooling changes, the cooling giving the greater coefficient. This would seem to indicate that the specimen was not completely dried and was losing moisture. Villari worked on wood which had been prepared by soaking in oil at 120° to 140° for 48 hours. This is a rather unusual treatment for wood, and it seemed of interest to find what its coefficient of expansion would be under other conditions.

Oven-dried Wood

In the present investigation the expansion was first determined for oven-dried specimens. The change in length was measured by means of two micrometer microscopes rigidly mounted and placed in front of a Freas electric oven with automatic temperature control. Coefficients were determined for both expansion and contraction and the constancy of the two coefficients was used as a check on the constancy of the moisture content. It is very important that the moisture content remain constant as a small change in this will mask the expansion due to change in temperature, especially when working with cross-section expansions.

Changes in temperature were determined by means of a standardized mercury thermometer placed directly over and almost in contact with the specimen under investigation. Any changes in the temperature of the mounting of the microscopes was observed and a correction made for this change.

The inner glass door of the oven was kept closed during a test and all the observations were taken through the door so that there would be no change in the thermal conditions.

Work on Wood Containing Moisture

Determinations were also taken on wood at room-dry conditions. It was found impossible to maintain the moisture content constant for room-dry specimens and so it was decided to determine the coefficient as the specimen was drying and then correct for the drying loss.

The rate of drying increases with the temperature while the rate of increase in temperature for a given run of the experiment decreases as the temperature nears the maximum. From a consideration of the first of these facts, it would appear that the average rate of drying would give too large a correction for the drying loss; but from the second fact it is seen that the specimen was above the average temperature for more than half the time which would tend to increase the loss and to a partial degree compensate for the other. Thus in making the correction the average rate of drying was used and it was considered that by so doing the error introduced was smaller than the other experimental errors of the determination.

Work on Oil-soaked Wood

White pine was also tested under conditions similar to those under which Villari tested his specimens. For this purpose the specimens were placed in hot neatsfoot oil at about 120° C. for 48 hours and then taken out and tested in the same manner that the dry specimens had been tested. It was found that under these conditions the results agreed to within from 1 to 8 per cent. with those of Villari.

Results for temperature range 20° to 50° C.

Wood	Condition	Coef. of expan. per ° C. x 10^4 Right angles to grain	Parallel to grain
White pine (Pinus Strobus)	dry	.636	.0365
	4% moisture	.727	
	5% moisture		.0400
	oil-soaked	.346	.0511
Basswood (Tilia Americana)	dry	.444	.0546
Tulip poplar (Liriodendron Tulipifera)	dry	.429	.0595
Hard maple (Acer Saccharum)	dry	.602	.0429
White ash (Fraxinus Americana)	dry	.458	.1100

The varieties of wood tested have been verified by Dr. Brown, of the New York State College of Forestry.

The results here given are of a preliminary nature and it is expected to extend the work to cover more

[1] E. Villari, *Annalen der Physik*, 133, p. 400, 1868.

[2] P. Glatzel, *Annalen der Physik*, 160, p. 497, 1877.

varieties of wood and wood under various conditions.

OTIS P. HENDERSHOT

STEELE HALL OF PHYSICS,
SYRACUSE UNIVERSITY,
SYRACUSE, N. Y., June, 1924.

THE EFFECT OF MINERAL SUPPLEMENTS ON GROWTH AND REPRODUCTION

THE effect of adding various mineral supplements to a basal ration of 2 parts of yellow corn and 1 part of peanut meal was tested on albino rats. The basal ration is often used for the feeding of swine in the south.

The plan of feeding was as follows:

Lot 1—Basal ration alone		
Lot 2—Basal ration	99	per cent.
NaCl	1	per cent.
Lot 3—Basal ration	97.5	per cent.
NaCl	1.0	per cent.
$CaCO_3$	1.5	per cent.
Lot 4—Basal ration	97.5	per cent.
NaCl	1.0	per cent.
Steamed bone meal	1.5	per cent.
Lot 5—Basal ration	97.5	per cent.
NaCl	1.0	per cent.
Acid phosphate	1.5	per cent.

EFFECT ON GROWTH

Lot 1 made very little growth. Lot 2 made gradual gains for a period of two to three months. This was followed by a decline in the weights of the males and approximate maintenance in the weights of the females.

The rate of growth in Lots 3, 4 and 5 was normal and was practically the same in all three lots during the first weeks of the experiment. The rats that received steamed bone meal, however, sustained their growth longer and reached a greater final weight on the average than those that received the $CaCO_3$ or the acid phosphate. The curves for the latter two lots were very similar.

EFFECT ON REPRODUCTION

The differences in reproduction were more striking than the differences in growth.

None of the females in Lots 1 and 2 showed signs of pregnancy.

In Lot 3 rearing of young was successful in the first litters of the second generation. Later litters did not grow so rapidly. The third generation was a failure.

Young were successfully raised in the fourth generation in Lot 4. The results in the third and fourth generations were not normal but were decidedly superior to those in any of the other groups.

Reproduction in Lot 5 was most disappointing in view of the fact that this group made about as good growth in the first generation as Lot 3. The females in Lot 5 littered fairly regularly, but the young were small, low in vitality and usually died within a few hours after birth.

Growth curves and analyses showing the ash content of the bodies of rats from each lot will be published later.

W. D. SALMON

ALABAMA EXPERIMENT STATION

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE FALL MEETING OF THE EXECUTIVE COMMITTEE

THE regular fall meeting of the executive committee of the council of the American Association was held at the Cosmos Club in Washington, on Sunday, October 12, with the following members present: Cattell, Humphreys, Livingston, Osborn, Ward. The following members were absent: Fairchild, Flexner, MacDougal, Miller, W. A. Noyes. In the absence of the chairman, the president of the association was elected chairman for the meeting. Three sessions were held, one in the forenoon, one in the afternoon and the third in the evening. A vote by mail has been taken among the absentee members on the items of business transacted at the meeting, this having been needed on account of the presence of only five members, six being required for a majority of the committee. The following items of business were transacted and have received the approval of more than a majority.

1. The election of Dr. F. G. Cottrell as chairman of Section C (Chemistry) was approved.

2. The permanent secretary's annual report on the affairs of the association was accepted. It will appear in SCIENCE in the near future.

3. The permanent secretary's annual financial report was accepted and ordered audited and then presented to the council.

4. The annual report of the assistant treasurer was accepted and ordered audited and then presented to the council.

5. It was voted that any funds appropriated for grants which shall not have been disbursed at the end of the fiscal year for which they were appropriated shall revert to the treasury as appropriable funds on October 1. It is, however, understood that this rule does not prejudice the possible transfer of any unused grant or any unused portion of a grant to the next fiscal year, providing this transfer be recommended by the Committee on Grants.

6. Six members were elected to fellowship.

7. It was recommended to the council that a fund of $3,000 be appropriated from the treasury for new allotments by the Committee on Grants for the fiscal year 1924–25.

8. It was recommended to the council that three emeritus life memberships on the Jane M. Smith Fund be established this year.

9. It was recommended to the council that a grant of $200 be made from the treasury funds for the Annual Tables of Physical and Chemical Constants for the year 1925.

10. The committee expressed its hearty appreciation of the excellent services given to the association by the executive assistant, Mr. Sam Woodley, who has charge of the regular business of the Washington office.

11. The permanent secretary was instructed to arrange for a classification of the several lines of activity of Section L (Historical and Philological Sciences) under two or three subsections, as may be desired by the special committees involved, a plan to be worked out for the alternation of the subsections in the organization of the section as a whole. The chairman of the Committee on Linguistic Sciences is to be chairman of the section committee for next year.

12. It was voted that entrance fees be regularly omitted in the following cases of persons who may join the association, according to the rule for new members of affiliated societies: (1) members of the local committee and its sub-committees for any meeting; (2) local representatives of sections for any meeting and (3) members of section committees.

13. The following fellows were named as occupants of the American Association table at the Naples Zoological Station for the periods shown:

Dr. Otto Glaser, February 1 to April 15, 1925.

Dr. A. R. Moore, April 15 to June 30, 1925.

14. Places for future meetings of the association were considered, but no action was taken. Future meetings thus far scheduled are as follows: Washington, December, 1924; Kansas City, December, 1925; Philadelphia, December, 1926; New York, December, 1928. The place for the annual meeting of December, 1927, remains undecided. The executive committee expressed its conviction that that meeting should be held in a southern city. Places for future summer meetings are undecided.

15. The gift of an oil painting of Dr. H. L. Fairchild was offered to the association by Miss Luella Agnes Owen. The offer was accepted with appreciative thanks.

16. It was voted that the Committee of One Hundred on Scientific Research be reorganized and continued.

17. The president of the association, Dr. J. McKeen Cattell, was elected chairman of the Committee of One Hundred on Scientific Research, and he was authorized to make appointments to fill vacancies on that committee and to name such officers and subcommittees as may be needed.

18. A progress report was accepted from Dr. Otis W. Caldwell, chairman of the special Committee on the Place of Science in Education. The work of this committee is now being taken up vigorously.

19. It was voted that disbursements from the special fund, provided by the Commonwealth Fund of New York, for the study of the place of science in education shall be made by the permanent secretary on vouchers approved by the chairman of the Committee on the Place of Science in Education.

20. The executive committee expressed its hearty approval of the arrangement by which Professor A. S. Eddington, of the University of Cambridge, is to give an evening lecture before the association on the third evening of the approaching fifth Washington meeting, December 31, 1924.

21. It was voted that the Second American Association Prize ($1,000), provided by an anonymous member of the association, be awarded at the close of the fifth Washington meeting in the same manner as was the first prize last year. The second prize is to be awarded for a noteworthy contribution to science presented at the fifth Washington meeting, either before a section of the association or before one of the organizations meeting with the association at that time. Membership in the association will not be considered in selecting the second prize man. Recommendations will be received by the permanent secretary's office during the meeting, from the secretaries of all sections and of all organizations meeting with the association. These recommendations will be used by the Committee on Award of the Second American Association Prize, the membership of which is to be named by the council at its first Washington session, Monday afternoon, December 29. This committee is to consist of five members representing different fields of science.

22. It was voted that a dinner and conference of the members of the executive committee and the association secretaries be arranged for the evening of Sunday, December 28, at Washington.

23. It was voted that the association will be glad to cooperate with the Pan-Pacific Union in any feasible way and a special committee to consider this cooperation was appointed, consisting of Drs. L. O. Howard, Herbert Osborn and B. E. Livingston.

24. It was voted that the association will be glad to cooperate with the National Conference on Outdoor Recreation in any fields in which its work coincides with that of the conference.

25. A letter from the American Museum of Safety, of New York, inviting the members of the association to visit the museum, which has recently been opened, was received with thanks. It was voted that the association heartily approves cooperation with the American Museum of Safety.

26. A letter from one of the members was read, suggesting the desirability of an association section or special program on the Science of Religion, and it was voted that the executive committee felt that, although some such arrangement may perhaps be ultimately desirable, yet it would not be feasible at present.

27. A letter from a member was received, suggesting the desirability of a national burying ground for the association. The executive committee expressed its feeling that such an arrangement would not be feasible.

28. The problem of the nature of fellowship in the association was discussed at length and the special committee on this subject was continued and asked to make recommendations at the next meeting of the executive committee. This committee consists of Drs. L. O. Howard, W. J. Humphreys and B. E. Livingston.

29. The arrangement of the affiliation of state academies was discussed at length and a special committee was appointed to make recommendations for improvement in this important relation at the next meeting of the executive committee. This committee consists of Drs. Herbert Osborn, Henry B. Ward and B. E. Livingston.

30. It was voted that the next meeting of the executive committee be called at 4 o'clock on Sunday, December 28, 1924, at Washington.

BURTON E. LIVINGSTON,
Permanent Secretary

THE NATIONAL ACADEMY OF SCIENCES

THE autumn meeting of the National Academy of Sciences was held on Monday and Tuesday, November 10 and 11, 1924, at Harvard University, Cambridge, Mass., and on Wednesday, November 12, 1924, at the building of the American Academy of Arts and Sciences, Boston.

The scientific program was as follows:

MONDAY, NOVEMBER 10, PIERCE HALL

Morning Session

The absorption of radiation by ozone in the atmosphere: CHARLES FABRY (introduced by S. W. Stratton).

The number of free electrons within a metal: E. H. HALL.

Contact potential difference of metals: E. H. HALL.

Recent measurements of the joule effect for carbon dioxide: F. G. KEYES and F. W. SEARS (introduced by S. W. Stratton).

The facts that influence the activity of atoms in organic compounds (by title): JAMES F. NORRIS (introduced by S. W. Stratton).

An equation for the Haber equilibrium (by title): L. J. GILLESPIE (introduced by S. W. Stratton).

The intensities of X-ray reflection: LOUIS HARRIS (introduced by S. W. Stratton).

The periodical structural regularities of spectra as related to the periodic law of the chemical elements: WILLIAM F. MEGGERS (introduced by G. K. Burgess).

New measurements of planetary radiation and planetary temperature: W. W. COBLENTZ and C. O. LAMPLAND (introduced by G. K. Burgess).

The aërodynamical characteristics of airfoils at high speed: L. L. BRIGGS, G. C. HILL and H. L. DRYDEN (introduced by G. K. Burgess).

The effect of tension on the transverse and longitudinal resistance of metals: P. W. BRIDGMAN.

A device for studying gaseous conduction at low pressures: VANNEVAR BUSH (introduced by S. W. Stratton).

The relativity motion of mercury: CHARLES L. POOR (introduced by G. C. Comstock).

The density of oxygen (by title): G. P. BAXTER and H. W. STARKWEATHER.

A theory for torsional stresses in curved skew bars (by title): PAUL HEYMENS (introduced by Edwin B. Wilson).

Biographical memoir of G. L. Goodale (by title): B. L. ROBINSON.

The spark spectrum of iron, with some remarks on spectral regularities (by title): H. N. RUSSELL.

Afternoon Session

The Cordierite-anthophyllite mineralization at Blue Hill, Maine, and its relation to similar occurrences: WALDEMAR LINDGREN.

Gel replacement, a new aspect of metasomatism: WALDEMAR LINDGREN.

Results of recent investigations of the form of the continental shelf bordering Eastern North America: DOUGLAS JOHNSON (introduced by J. F. Kemp).

The occurrence of Cordilleran and other Western plants in Eastern America (illustrated): M. L. FERNALD (introduced by B. L. Robinson).

Remarks on the glacial geology of Martha's Vineyard island: EDWARD WIGGLESWORTH (introduced by W. Lindgren).

Recent work in oceanography: HENRY BIGELOW (introduced by E. L. Mark).

The new research station on Barro Colorado Island in Gatun Lake: THOMAS BARBOUR (introduced by W. M. Wheeler).

Biological characters in the differentiation of Avian Coccidia: E. E. TYZZER (introduced by Reid Hunt).

Summary of results thus far obtained by the Third Asiatic Expedition of the American Museum: H. F. OSBORN.

The five chief factors in evolution: H. F. Osborn.

Tuesday, November 11, Pierce Hall

Morning Session

Heat of formation of nitrogen trichloride: W. A. Noyes and W. F. Tuley.

Internal pressures produced by chemical affinity: Theodore Richards.

Studies in catalysis: H. W. Sherwood, Jr. (introduced by S. W. Stratton).

The mechanism of reactions in the urea series: T. L. Davis (introduced by S. W. Stratton).

The manner of occurrence of caffein in the coffee bean: S. C. Prescott (introduced by S. W. Stratton).

On crystallized animal proteins: E. J. Cohn (introduced by L. J. Henderson).

Characterization of proteins: S. R. L. Sörensen (introduced by A. B. Lamb).

Afternoon Session

On multiple relations: A. N. Whitehead, F.R.S. (by invitation).

Doubtful measurements: J. L. Coolidge (introduced by H. S. White).

Geometries defined by a linear differential form: C. L. E. Moore (introduced by S. W. Stratton).

The frequency distribution on apparent magnitude of the non-Magellanic O-type stars: E. B. Wilson and W. J. Luyten.

The age of the stars (by title): Edward Condon (introduced by A. O. Leuschner).

The population of New York City and its environs: E. B. Wilson and W. J. Luyten.

Tidal oscillation of the Lava Lake of Kilauea: E. W. Brown.

Time constants: E. A. Kennelly.

Controlled orbital transfers of electrons in optically excited mercury atoms: R. W. Wood.

Influence of strain and of heat on the hardness of iron and steel: Albert Sauveur (introduced by G. F. Swain).

Regarding the experiments of Hiram F. Mills on the flow of water in pipes: G. F. Swain.

A problem of electric power transmission: D. C. Jackson (introduced by S. W. Stratton).

Drowning period of crocodiles: G. H. Parker.

Experiments on medulla and spinal cord grafts in embryos: S. R. Detweiler (introduced by G. H. Parker).

The finding of the Queen of Eciton Hamatum Fabricus: W. M. Wheeler.

Wednesday, November 12, at 28 Newbury Street, Boston

Morning Session

Bacterial allergy: Hans Zinsser.

The diffusing capacity of the capillary bed: L. J. Henderson and C. D. Murray.

Skew growth curves: R. Pearl and L. J. Reed.

The influence of diet upon the growth and structure of the kidney: T. B. Osborne, L. B. Mendel, E. A. Park and M. C. Winternitz.

The effect of small amounts of fluorine in the diet of the rat: E. V. McCollum.

The skin temperature of men and women: F. G. Benedict.

Prolonged fasting of steers as affecting the constituents of urine: T. M. Carpenter (introduced by F. G. Benedict).

Chemical studies in tuberculin: J. H. Mueller (introduced by H. Zinsser).

Some effects of arsonium, stibonium and analogous compounds on the autonomic nervous system: Reid Hunt and R. R. Renshaw.

Virus encephalitis in the rabbit: Simon Flexner.

The cultivation of the dysentery amoeba: W. C. Boeck (introduced by R. Hunt).

Gaseous interchanges in the stomach and intestine: M. A. McIver (introduced by W. W. Cannon).

Conduction without decrement in narcotized nerve: Alexander Forbes and Hallowell Davis (introduced by W. B. Cannon).

Afternoon Session

The respiratory function of the hemocyanins: A. C. Redfield and A. L. Hurd (introduced by W. B. Cannon).

Studies in the life history of Artemia sabina principalis, Simon: G. G. Martin (introduced by W. B. Cannon).

On the occurrence in rabbits of linkage inheritance between albinism and brown pigmentation: W. E. Castle.

The nature of association between Anthozoa and Zooxanthellae: H. Boschma (introduced by E. L. Mark).

Symbiosis between Chlorella sp. and Azotobacter chrococcum and nitrogen fixation: C. B. Lipman and L. J. H. Teakle (introduced by A. O. Leuschner).

Localized form-controlling agencies in hydra and planaria: H. W. Rand (introduced by G. H. Parker).

Some peculiarities in the distribution of New England flies: C. W. Johnson (introduced by W. M. Wheeler).

Certain aspects of the sugar cane disease in Cuba: W. H. Weston (introduced by W. J. V. Osterhout).

Recent aspects of Central America orchid flora: O. Ames (introduced by B. L. Robinson).

Hybridism in the genus Isöetes: E. C. Jeffrey (introduced by G. H. Parker).

The gorilla in the Eastern limits of its range: J. C. Phillips (introduced by W. E. Castle).

The dispersal of the bats of the genus Microtis: G. M. Allen (introduced by L. Stejneger).

The British Museum collection of recent sea-urchins: H. L. Clark (introduced by G. H. Parker).

Observations on the fauna of thermal waters: C. T. Brues (introduced by W. M. Wheeler).

Differences in the physico-chemical composition of the cells of the central nervous system as revealed by specific impregnation methods (by title): Harvey Cushing and Percival Bailey.

Formation of urine by the kidneys (by title): Joseph T. Wearn (introduced by H. Zinsser).

Evening Session

Being the one thousand one hundred and thirty-fourth meeting of the American Academy of Arts and Sciences.

Spread of ideas in the Middle Ages (discussion by H. O. Taylor): C. H. Haskins (by invitation).

Some causes of volcanic activity: Arthur L. Day.